

The logo for Total Ship Systems Engineering (TSSE) features the letters 'TSSE' in a large, bold, italicized sans-serif font. A thick horizontal line extends from the top of the 'S' across the top of the page, ending in a silhouette of a ship's superstructure with several masts or antennas.

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Total Ship System Engineering TSSE

**1996 Student Capstone Project
An Arsenal Ship Design**

TSSE Faculty

- Chuck Calvano, TSSE Program Head, Ship Design**
- Bob Harney, Combat Systems**
- Fotis Papoulias, Naval Architecture**
- Bob Ashton, Shipboard Electrical Power**

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TSSE PROGRAM

- **PROVIDE A BROAD BASED, SYSTEMS ENGINEERING AND DESIGN ORIENTED CURRICULUM...**
- **FOCUSING ON THE WARSHIP AS A TOTAL ENGINEERING SYSTEM...**
- **INCLUDING HULL, MECHANICAL, ELECTRICAL (HM&E) AND COMBAT SYSTEMS**

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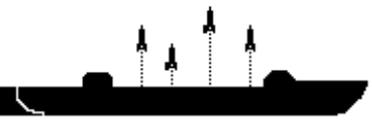
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WHY THE ARSENAL SHIP?

- ACTUAL ARSENAL SHIP ACQUISITION PROGRAM IN PROGRESS
- STUDENT ARSENAL SHIP DESIGN AT THE REQUEST OF ASSISTANT SECRETARY OF THE NAVY JOHN W. DOUGLASS
 - BACKGROUND INFORMATION FOR NAVY SENIOR PERSONNEL FOR ARSENAL SHIP ACQUISITION

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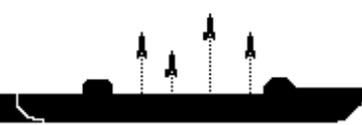


TSSE

**TOTAL SHIP
SYSTEMS
ENGINEERING**



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OVERVIEW OF PRESENTATION

- **TSSE PROGRAM AND PROBLEM STATEMENT**
- **GENERAL OVERVIEW OF SHIP DESIGN**
 - **CONCEPT OF EMPLOYMENT AND OPERATIONS**
 - **COMBAT SYSTEM SELECTION AND DESIGN**
 - **HM&E DESIGN**
- **CLOSING COMMENTS**
- **BREAK**
- **DETAILED REVIEW OF SELECTED TOPICS**



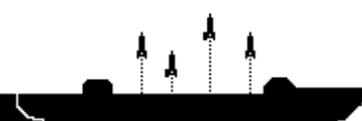
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THE PEOPLE

- 15 STUDENTS
 - 10 USN
 - 1 AVIATOR
 - 1 SURFACE WARFARE OFFICER
 - 6 ENGINEERING DUTY OFFICERS (FORMER SWO)
 - 2 ENGINEERING DUTY OFFICERS (FORMER SUB)
 - 4 USCG NAVAL ENGINEERS
 - 1 USMC INFANTRY/LIGHT ARMOR OFFICER



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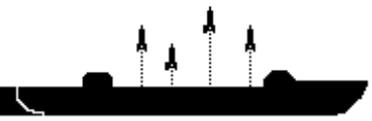


PROBLEM STATEMENT

- FIRST ITERATION OF DESIGN FOR AN ARSENAL SHIP
- PRIMARY CONSTRAINTS
 - 550 MILLION DOLLARS MAX USP
 - 50 CREW MAX
 - SURVIVABILITY
 - 22 KNOT SUSTAINED SPEED
 - APPROXIMATELY 500 MISSILE CELLS



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OUR APPROACH

- FUNCTION AS A PROGRAM OFFICE
- PROJECT MANAGEMENT
 - PROF CALVANO
 - PROF HARNEY
- TEAMS
 - OPERATIONS GROUP
 - COMBAT SYSTEMS GROUP
 - HULL, MECHANICAL & ELECTRICAL GROUP

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OPERATIONS GROUP

- **AREA OF RESPONSIBILITY**
 - **OPERATIONAL CONCEPTS**
 - **DAY - TO - DAY SHIP FUNCTIONS**
 - **DAMAGE CONTROL**
 - **MAINTENANCE MANAGEMENT**
 - **SPECIAL EVOLUTIONS**
 - **MANNING**



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COMBAT SYSTEMS

- AREA OF RESPONSIBILITY
 - COMMAND AND CONTROL
 - CEC LINK
 - WEAPONS SUITE
 - SENSOR SUITE
 - MISSILE LAUNCHER SYSTEM

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H M & E

- AREA OF RESPONSIBILITY
 - HULL DESIGN
 - PROPULSION PLANT
 - ELECTRICAL PLANT
 - GENERAL ARRANGEMENTS
 - SURVIVABILITY

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OPERATIONAL ISSUES

Thinking Outside the Box

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THE ARSENAL SHIP IS...

- CREWED WITH LESS THAN 50 PERSONNEL
- **NOT** A TARGETING AND FIRE CONTROL PLATFORM
- VIRTUALLY UNSINKABLE
- DESIGNED WITH HIGH RELIABLE, LOW MAINTENANCE SYSTEMS
- CAPABLE OF REFUELING AT SEA
- CAPABLE OF TRANSITING THE PANAMA AND SUEZ CANALS
- CAPABLE OF A SUSTAINED SPEED OF 22 KNOTS

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THE ARSENAL SHIP CAN...

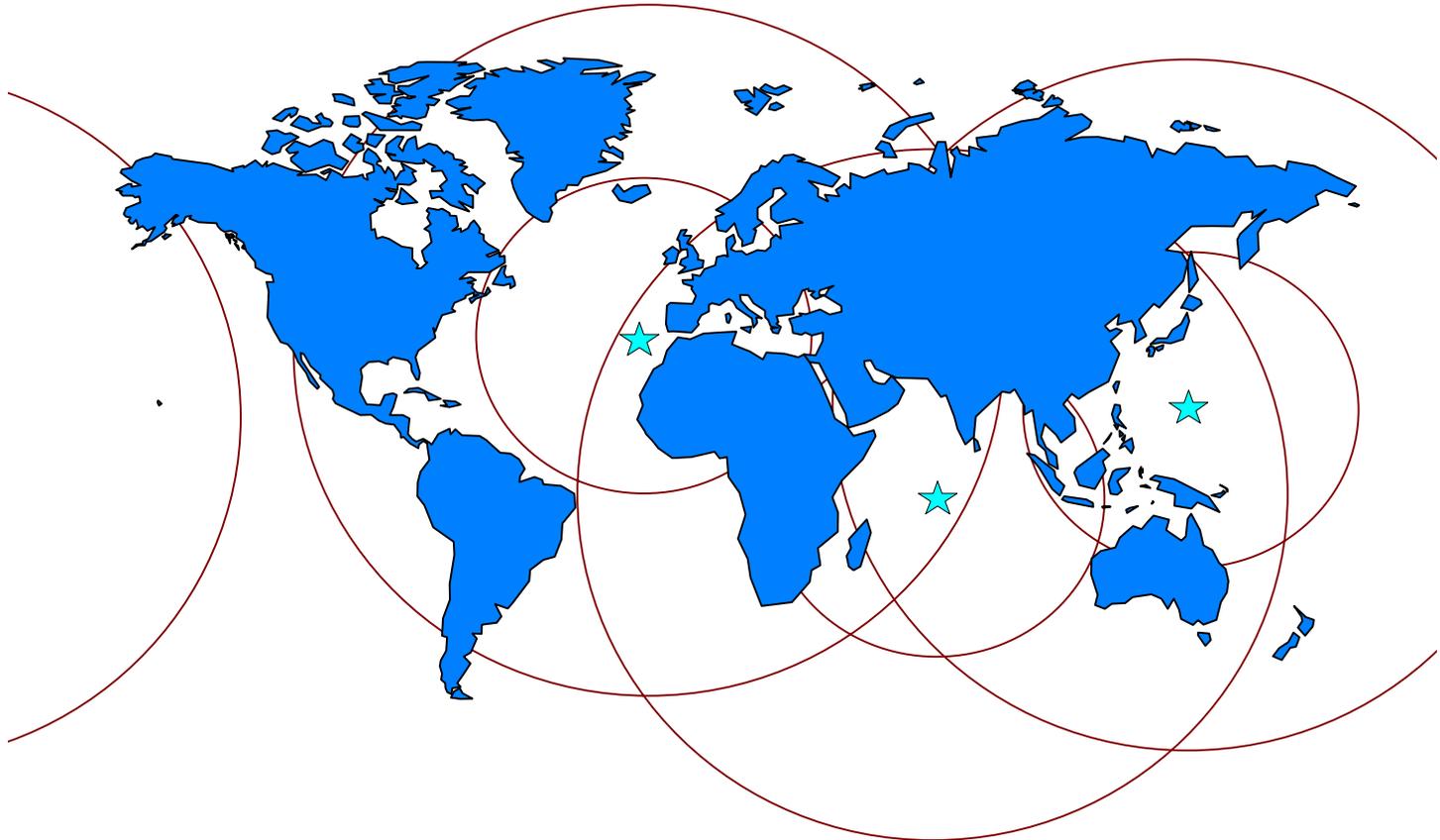
- **SUPPLY MASSIVE FIREPOWER IN EARLY PHASES OF A CONFLICT**
- **FULLY INTEGRATE INTO A JOINT WARFIGHTING FORCE**
- **MAINTAIN FULL TIME COMMUNICATIONS OVER VOICE AND DATA CHANNELS**
- **CONTINUOUSLY AVAILABLE FOR RAPID MOVEMENT UPON RECEIPT OF STRATEGIC WARNING**
- **BE FORWARD STATIONED FOR INDEFINITE PERIODS OF TIME**

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ARSENAL SHIP REACH





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ARSENAL SHIP SCHEDULE

SHIP A

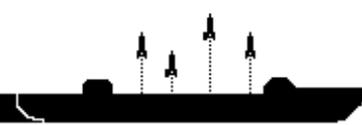
- MONTHS 1-6
 - AT SEA WITH SUPPORTED BATTLE GROUP
- MONTHS 7 - 11
 - LOCAL OPERATIONS AND MAINTENANCE. ARSENAL SHIP IS IN THEATER RESERVE.
- MONTH 12
 - CREW TURNOVER

SHIP B

- MONTHS 1 - 5
 - LOCAL OPERATIONS AND MAINTENANCE. ARSENAL SHIP IS IN THEATER RESERVE.
- MONTH 6
 - CREW TURNOVER
- MONTHS 7-12
 - AT SEA WITH SUPPORTED BATTLE GROUP



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MANPOWER TEMPO

- ASSIGNED TO ARSENAL SHIP PROGRAM
- REPORTS TO TRAINING COMMAND FOR CREW FORMING AND TRAINING
 - 6 MONTHS
- DEPLOYS TO ARSENAL SHIP
 - 12 MONTHS
- RETURNS TO CONUS
 - POST DEPLOYMENT LEAVE
 - TRANSFERRED
 - JOINS ANOTHER CREW

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COMMAND AND CONTROL VISION

- GENERAL SUPPORT ASSET
 - NATIONAL COMMAND AUTHORITY
 - FLEET COMMANDER
- DIRECT SUPPORT ASSET
 - REMOTE MAGAZINE FOR AIR DEFENSE
 - SURFACE FIRE SUPPORT PLATFORM

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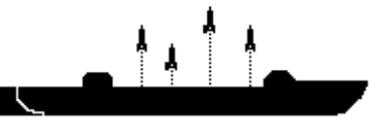
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DESIGN PHILOSOPHY

- HIGH MISSION CAPABILITY
- LOW COST
- SURVIVABLE



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DESIGN FOR REDUCED MANNING

- MAX CREW OF 50
- BASIC CONCEPTS
 - EQUIPMENT
 - TECHNIQUES

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EQUIPMENT

- **AUTOMATION**
 - **BRIDGE/NAVIGATION SYSTEM**
 - **MACHINERY CONTROL**
- **RELIABILITY**
 - **DIESEL ENGINES/GENERATORS**

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TECHNIQUES

- SPECIAL EVOLUTIONS
- CASHLESS/PAPERLESS SHIP

TRUST THE COMPUTER



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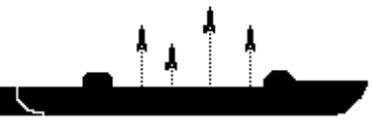


TABLE OF ORGANIZATION

| LINE # | BILLET | RANK | QUANTITY | WATCHSTANDER | COMMENTS |
|--------|----------------------------------|-----------|----------|--------------|-------------------------|
| 1 | CAPTAIN | O-5 | 1 | NO | |
| 2 | EXECUTIVE/MAINTENANCE OFFICER | O-4 | 1 | YES | CSOW |
| 3 | WEAPONS OFFICER | O-4 | 1 | YES | CSOW |
| 4 | OFFICER OF THE DECK | O-3 | 4 | YES | DEPARTMENT HEADS |
| 5 | JOOD | E-7/8 | 4 | YES | DIVISION OFFICERS |
| 6 | COMM SPECIALIST | E-5/6 | 4 | YES | |
| 7 | ENGINEERING OFFICER OF THE WATCH | E-7/8 | 4 | YES | DIVISION OFFICERS |
| 8 | EW SPECIALIST | E-5/6 | 4 | YES | |
| 9 | DECK FORCE | E-5/6 | 5 | NO | |
| 10 | HM&E FORCE | E-4/5 | 5 | NO | |
| 11 | COMBAT SYSTEM FORCE | E-4/5/6/7 | 8 | NO | ONE E-7 & SEVEN E-4/5/6 |
| 12 | CORPSMAN | E-5/6 | 1 | NO | |
| 13 | MESS SPECIALIST | E-4/5/6 | 2 | NO | ONE E-5/6 & ONE E-4/5 |
| | | OFFICER | 7 | | |
| | | CHIEFS | 9 | | |
| | | ENLISTED | 28 | | |
| | | | 44 | | |



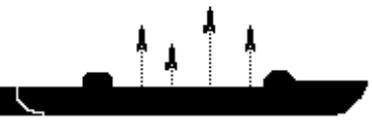
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Combat Systems Team

- LCDR Mike Chase, USN
- LT Dennis Florence, USN
- LT Tom Heater, USN
- LT Chris Holmes, USN
- LT Andy Rowe, USN



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Combat Systems Brief

- Combat systems concept of design
- Arsenal Ship combat systems
- Remote firing capability
- Advanced Tactical Weapon Control System
- Launcher systems
- Communications
- Self defense systems

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Combat System Concept of Design

- Meet mission requirements
- Best value for acquisition and life cycle cost
- Remote magazine for Aegis control ship
- Capable self defense
- Future growth built in early
- Final design based on ACTD progress

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Arsenal Ship Combat System

- SM-2, TLAM, ATACM, VGAS
- Concentric Canisterized Launcher
- CEC/link 16/link 22
- C4I: Joint Maritime Communications Strategy -- MERS, LOMS
- SSDS, RAM, Nulka, IR decoys, Rubber Duck, AIEWS

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Remote Firing Capability

- Response times equivalent to control ship
- Seamless joint operations
- Must allow for simultaneous control of missiles from multiple platforms
- Cooperative Engagement Capability
- Advanced *Tactical* Weapon Control System
- Vertical Launching System

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CEC

- Provides necessary bandwidth
- Proven reliability
- Known hardware
- Easily modified to handle different data types (processor)

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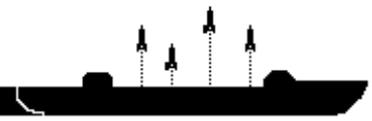
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ATWCS

- Next generation weapon control system
- Open architecture, COTS
- Expanded storage capacity
- Ethernet networks and fiber optics
- Accommodate all missiles and guns
- Supports time critical data



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Integrating Weapons

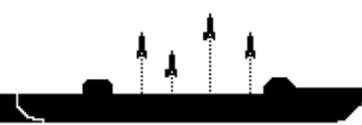
- SM-2
 - Initialization Acquisition Illumination

- TLAM
 - Planning Alignment VLS

- ATACMS
 - Software GPS Inventory



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Launcher Systems

- Concentric Canisterized Launcher concept
 - Increased passive survivability
 - Less maintenance
 - Cheaper, perhaps
- Mk 41 Vertical Launch System
 - Proven technology
 - Affordable, flexible

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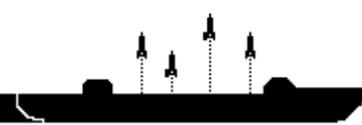
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Joint Maritime Communications Strategy

- Digital Network System
 - Multifunction Electromagnetic Radiating System
- Integrated Terminal Program
- Automated Digital Network System
 - Low Observable Multifunction Stack



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Communication

- Links --CEC/Link 16/Link 22
- HF, VHF/UHF SINGARS
- OTCIXS, TADIXS, UHF FLTSATCOM
- Milstar, UFO/E, FEP
- Defense Satellite Communications System
- INMARSAT, INTELSAT



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Network

- Survivable Adaptable Fiber Optic Embedded Network (SAFENET) and Fiber Distributed Data Interface (FDDI)
- 100 Mbytes/sec, 240 taps
- Cheap, commercial availability/standards
- Government Open System Interconnection Profile (GOSIP)



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Self Defense Systems

- SSDS
- AIEWS
- RAM Block 0/1
- Mk 53 Decoy Launching System
- SLQ-49 Rubber Duck
- NULKA

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HULL MECHANICAL AND ELECTRICAL TEAM

- **LT GREGG BAUMANN**
- **LT JEFF BROWN**
- **LT JIM SEBASTIAN**
- **LT BRIAN ELLIS**
- **LT MIKE FRANCE**

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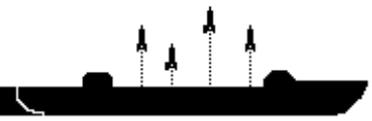
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HULL ALTERNATIVES

- SWATH / SLICE
- SPECIALTY HULLS
- SEMI-SUBMERSIBLE
- MONO-HULL (TANKER/CARGO)



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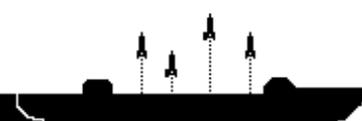


HULL SELECTION

- USNS T-AO CLASS OILER
- PRINCIPAL CHARACTERISTICS
 - LBP 650 FT
 - BEAM 97.7 FT
 - DRAFT 34.5 FT
 - SPEED 22 KT
 - DISPLACEMENT 38,000 TONS



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PROPULSION PLANT

- COLT PIELSTICK 4.2V18
- 30,000 HP INSTALLED
- MECHANICAL TRANSMISSION
- PTO 2500 KW
- CONTROLLABLE PITCH PROPELLERS
 - twin screw



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ELECTRICAL PLANT

- **AC POWER GENERATION**
- **ZONAL DISTRIBUTION 15 ZONES 3 BUSSES**
- **2 SS POWER TAKE OFF GENERATORS**
- **3 SS DIESEL GENERATORS**
- **12,500 KW INSTALLED**

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NAVAL ARCHITECTURE BALANCED W/ SURVIVABILITY

- **DOUBLE HULL DESIGN**
- **VLS SEPARATION**
- **17 TRANSVERSE BULKHEADS**
- **CONCRETE BALLAST IN DBL HULL**
- **HULL SIDE PROTECTION**
- **TOPSIDE SIGNATURE**

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MEETS MISSION GOALS!

- CREW OF LESS THAN 50
- REMOTE FIRING BATTERY
- OPERATES AS A JOINT PLATFORM
- SURVIVABLE
- SUSTAINED SPEED OF 22 KNOTS
- 500+ VLS CELLS
- AFFORDABLE

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COST SAVINGS THROUGH MODIFIED REPEAT

- **SAVES DESIGN AND ENGINEERING**
- **PROVIDES MORE MONEY FOR
COMBAT SYSTEMS EQUIPMENT**
- **PROVEN HULL DESIGN**

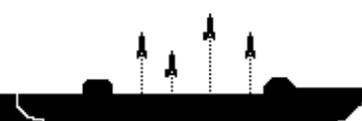
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**THINK
OUTSIDE
THE BOX!**



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A SPECIAL THANKS TO...

- NSWC DAHLGREN, CARDEROCK AND PORT HUENEME
- NAVAL RESEARCH LAB
- CENTER FOR NAVAL ANALYSES
- SUPSHIP NEW ORLEANS
- DARPA
- TECHNICAL CODES OF NAVSEA
- APPLIED PHYSICS LAB AT JOHN HOPKINS UNIV
- THEATER AIR DEFENSE PROGRAM EXECUTIVE OFFICE
- SMART SHIP PROGRAM OFFICE
- OPERATIONS ANALYSIS DEPARTMENT AT NPS